

REMARKS

Entry of the foregoing amendments and favorable reconsideration of the subject application is respectfully requested in view of the following comments.

Claims 1-10 are currently pending in the subject application. Claims 3, 4, 6, 7, 9 and 10 have been cancelled as non-elected in response to the Restriction Requirement of January 13, 2006, although Applicants reserve the right to file a divisional application covering these non-elected claims. Claim 1 has been amended herein. Accordingly, claims 1, 2, 5 and 8 are herewith represented for the examiner's consideration.

The foregoing amendments have been made in response to the examiner's comments in the outstanding Office Action and following review of the specification and claims by Applicants.

Specifically, the amendments to the abstract and the specification at page 3 have been made in response to the examiner's comments in the rejection under 35 U.S.C. 112, first and second paragraphs, particularly paragraphs 1-3 thereof. Applicants respectfully submit that the confusion with respect to the reference to R_1-R_6 is the result of a typographic error and that " R_1-R_6 " should be $--R_5-R_6--$. The amendments have corrected this typographic error. In addition, Applicants have repositioned general formula (1) after the language of "reacting aromatic compound represented by general formula (1) and epihalohydrin" as suggested by the examiner in paragraph 3 of the rejection. Applicants respectfully submit that this

repositioning together with correction of the typographic error clarify any confusion in understanding the present invention and do not add any new matter to the specification or abstract.

The amendment to the paragraph on page 4 has been made in response to the examiner's comment in paragraph 4 of the Office Action that the 4,4'-[(1,4-phenylene)bis(isopropylidene)]bis(2-methylphenol), and 4,4'-[(1,4-phenylene)bis(isopropylidene)]bisphenol listed therein do not conform to the aromatic compound of general formula (1). By this amendment, Applicants have deleted the reference to these compounds from the specification.

In reviewing the English language specification, Applicants noted an error in Table 1 at page 16. Specifically, in reference to the resin used in Comparative Example 3, the Table mistakenly identifies it as the "resin of Reference Example 2" when it should be the --resin of Reference Example 1--. This is clearly evident from the description of Comparative Example 3 at lines 7-9 on page 15, where it is stated: "By the same process to Example 8 except changing the epoxy resin of Example 7 to the crystalline epoxy resin of Reference Example 1, the powder coating of 45µm particle size was prepared." Accordingly, Applicants have corrected the reference in Table 1.

Claim 1 has been amended in response to the examiner's rejections under 35 U.S.C. 112, first and second paragraphs to correct the typographic error of "R₁-R₆" to --R₅-R₆-- and to

reposition general formula (1) after the language of "reacting aromatic compound represented by general formula (1) and epihalohydrin" as suggested by the examiner in paragraph 3 of the rejection. In addition, claim 1 has been amended to specify that the epoxy resin is "a non-crystalline" epoxy resin. This condition of the epoxy resin is evident from the specification, for example, at page 5, lines 9-13, where it is stated: "In the present invention, the object of the invention is not to make crystallinity as the necessary and enough condition, but to use the epoxy resin having high symmetrical structure and to enlarge the applicability for use in the resin state which does not generate crystallinity." In addition, Examples 1-3 specifically state that the resin obtained in those examples is non-crystalline. Accordingly, Applicants respectfully submit that the amendment to recite the epoxy as non-crystalline is fully supported by the specification as filed.

In view of the foregoing amendments and comments, Applicants respectfully submit that the examiner's rejections under 35 U.S.C. 112, first and second paragraphs as applied to claims 1, 2, 5 and 8 have been overcome and respectfully request that those rejections be withdrawn.

With regard to the prior art, the examiner has rejected claims 1 and 5 under 35 U.S.C. 103(a) as unpatentable over Hartmann, U.S. 4,153,621. Hartmann is cited as depicting a general structure for the polymerized diglycidyl ether of 3,3',5,5'-tetraalkyl-4,4'-dihydroxybiphenyl (cols. 3-4, first

general structure) wherein the biphenyl β -hydroxypropylether repeating unit quantified by "n" is zero or an integer utilized in the fabrication of a cured product (col. 6, lines 22-32). It is noted that the examiner admits that the claimed content of n=0 of at most 60% and an epoxy equivalent weight of at least 250 are not recited in the reference.

Hartmann is also cited as teaching the production of lower molecular weight glycidyl ethers when a ratio of epichlorohydrin to dihydric phenol of higher than 2:1 is employed (col. 3, lines 30-32). "Thus, by decreasing the mol ratio of epichlorohydrin to dihydric phenol from 14 towards two, glycidyl ethers having higher values of n and higher epoxy equivalents can be obtained (col. 3, lines 38-41)."

The examiner contends that it would have been obvious to react epichlorohydrin with the 3,3',5,5'-tetraalkyl-4,4'-dihydroxybiphenyl at a molar ratio approaching 2:1 in order to mitigate the formation of lower molecular weight glycidyl ethers to within the claimed parameters of at most 60% and to predominantly form higher molecular weight glycidyl ethers with larger epoxy equivalents greater than the claimed minimum of 25 g/eq.

Applicants respectfully submit that, although Hartmann discloses a glycidyl ether comprising the condensation product of a halohydrin and 3,3',5,5'-tetraalkyl-4,4'-dihydroxybiphenyl, such disclosure is insufficient to support the examiner's rejection of the claims as amended herein.

Applicants point out that the present invention recites a non-crystalline epoxy resin which is specifically characterized as having a content of n=0 of 60% or less and an epoxy equivalent of 250 g/eq or more. As the examiner has already admitted, these characteristics are not recited in the reference. Furthermore, there is nothing in the disclosure of Hartmann to even suggest to one of ordinary skill in the art that such limitations should be pursued in such compositions or that they would have a desirable affect on the properties of the epoxy resin.

Hartmann, it is noted, discloses:

"In practice, however, a higher ratio than 2 mols of epichlorohydrin per mol of dihydric phenol is desirable, particularly to form lower MW glycidyl ethers. Molar excesses of up to 14 mols of epichlorohydrin per mol of dihydric phenol may be utilized to form the glycidyl ether of the phenol. The value of n and extent of polymerization can be varied by changing the mol ratio of epichlorohydrin to dihydric phenol within the range of 14-1 to 2-1. Thus, by decreasing the mol ratio of epichlorohydrin to dihydric phenol from 14 towards 2, glycidyl ethers having higher values of n and higher epoxy equivalents can be obtained (col. 3, lines 30-41)."

However, this passage relates to a method for the preparation of an ordinary epoxy resin.

In contrast, when one looks at the Examples of Hartmann, it is evident that the object of the reference is the production of a crystalline 3,3',5,5'-tetraalkyl-4,4'-dihydroxybiphenyl and a crosslinked product thereof, wherein the content of the n=0 compound is more than 88%. In this regard, it is noted that the desirable embodiment of the reference is 3,3',5,5'-tetraalkyl-4,4'-dihydroxybiphenyl (TMBP-DGE) characterized in that the

content of impurity is small, the melting point is 113-115°C and the epoxy equivalent (WPE) is 185 (Col. 5, lines 6-10). Indeed, Example 1 discloses a TMBP-DGE with an epoxy equivalent of 190 and melting point of 97-102°C. Examples 2-4 provide a TMBP-DGE with an epoxy equivalent of 195 and Examples 6-8 provide a TMBP-DGE with epoxy equivalents of 185-187.5 and melting point of 105-114°C. From these characteristics it is understood that the epoxy resins of the reference are lower molecular weight epoxy resins having crystallinity.

In contrast, the epoxy resins of the present invention are non-crystalline.

Furthermore, in the case of an epoxy resin as described in the reference and having the general structural formula (TMBP-DGE) mention in columns 3-4, the theoretical epoxy equivalent can be calculated as 177. When this is compared with the epoxy equivalents described in Examples 1-4 and 6-8, it is evident that the average polymerization degree n of these examples is close to 0 and it is understood that the main component of the reference composition is the $n=0$ component. The relationship between the epoxy equivalent and n of the epoxy resin of Hartmann is indicated by $354 + (298)n = 2 \times \text{WPE}$. Thus, in the case of an epoxy equivalent of 184, $n=0.05$. In the case of an epoxy equivalent of 190, $n=0.09$ and in the case of an epoxy equivalent of 195, $n=0.12$.

From the foregoing, it is evident that the epoxy compositions disclosed by Hartmann are crystalline compositions

having a content of the n=0 component of 88% or more and epoxy equivalents of less than 200 g/eq. In contrast, the epoxy resin of the present invention is a non-crystalline epoxy resin having a content of the n=0 component of 60% or less and epoxy equivalent of 250 g/eq or over and is neither disclosed nor suggested by the Hartmann reference despite the examiner's cited suggestion that "by decreasing the mol ratio of epichlorohydrin to dihydric phenol from 14 towards two, glycidyl ethers having higher values of n and higher epoxy equivalents can be obtained."

Nothing in Hartmann supports a non-crystalline epoxy resin having a content of the n=0 component of less than 88% and an epoxy equivalent of more than 200. Accordingly, Applicants respectfully submit that the examiner's rejection of claims 1 and 5 under 35 U.S.C. 103(a) over Hartmann is without support and should be withdrawn.

Claims 1, 2, 5 and 8 have been rejected under 35 U.S.C. 103(a) as being unpatentable over Kawano, et al., U.S. Publication No. 2003/0175571 in view of Hartmann.

The examiner cites Kawano, et al., as exhibiting, at page 1, paragraphs 6 and 7, general formula 1, an optionally C₁₋₆ hydrocarbon-substituted bisphenol F diglycidyl ether wherein the β -hydroxypropylether diphenyl methane repeating unit is as high as 15 used in a cured product (page 3, paragraph 30).

Again, the examiner admits that the claimed content of n=0 of at most 60% and an epoxy equivalent weight of at least 250 are not recited in the reference.

However, the examiner contends that it would have been obvious to prepare the polymerized diglycidyl ether of bisphenol F with a molar ratio of near 2:1 as espoused in Hartmann in order to reduce the yield of lower molecular weight glycidyl ethers to within the claimed range of at most 60% and to produce a predominance of higher molecular weight glycidyl ethers with larger epoxy equivalents exceeding the claimed minimum of 250 g/eq.

Applicants point out that the C₁₋₆ hydrocarbon substituted bisphenol F diglycidyl ether of Kawano is a crystalline epoxy resin and is different from the non-crystalline epoxy resin of the present invention. Indeed, the substituted bisphenol F resin used in Example 2 of the reference is identified as a tetramethylbisphenol F type epoxy resin with the commodity name of YSLV-80XY available from Nippon Steel Chemical with a melting point of 75-80°C. This is substantially the same as the diglycidylether resin of 3,3',5,5'-tetramethyl-4,4'-dihydroxyldiphenyl methane (YSLY-80XY) used in Reference Example 1 of the present invention (page 10, line 25 to page 11, line 3) which is a product of Shin-Nittetsu Chemicals, Co., Ltd. As shown in the results for Comparative Example 3 in Table 1 at page 16 of the present application, the flexibility of the crystalline substitute bisphenol F resin is inferior to the resins of the present invention.

Accordingly, Applicants respectfully submit that the examiner's suggestion that it would have been obvious to prepare

the polymerized diglycidyl ether of bisphenol F with a molar ratio of near 2:1 as espouse in Hartmann is irrelevant to the present invention since the reference effectively teaches a different composition from that recited in the present claims.

Furthermore, the gel permeation chromatograph (GPC chart) for the resin YSLY-80XY of Reference Example 1 of the present invention is shown in Fig. 1A where it is clear that the tetramethyl bisphenol F epoxy resin as the n=0 component as the main component (29.8 min by TIME on the GPC chart) while the n=1 component is at 28.30 min on the GPC chart. The amount of the n=0 component is clearly in excess of the 60% maximum recited in the present claims.

Since the tetramethyl bisphenol F epoxy resin of the Reference Example 1 is substantially the same as that disclosed by Kawano, Applicants respectfully submit that the reference merely discloses the resin used by Applicants as a reference against which the non-crystalline epoxy resin of the present application is compared. The reference neither discloses nor suggests the non-crystalline epoxy resin of the present invention having a content of n=0 component of 60% or less and an epoxy equivalent of 250 g/eq or more. For the reasons given previously herein, the addition of the Hartmann reference does not cure the deficiencies of the Kawano reference since Hartmann fails to disclose or teach a non-crystalline epoxy resin represented by general formula (2) as recited in the present claims having the content of n=0 component of 60% or less and an

epoxy equivalent of 250 g/eq or more.

In view of the foregoing, Applicants respectfully submit that there is no motivation in either Hartmann or Kawano to modify the teachings therein to achieve the non-crystalline epoxy resin of the present invention.

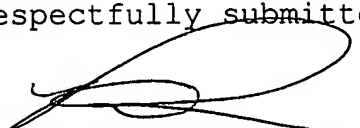
Furthermore, Applicants have continued their study to obtain an epoxy resin which provides a cured product superior in mechanical features, heat resistance, water resistance and adhesion which does not exhibit crystallinity and a bisphenol A epoxy resin skeletal structure. As a result, it has been found that by providing a broad molecular weight distribution to the epoxy resin having the molecular structure represented by general formula (2), the improved heat resistance, water resistance and adhesion exhibited by the present invention is obtained.

Indeed, as set forth in the specification of the present application, the epoxy resin of the present invention is characterized as the polymer epoxy resin having an epoxy equivalent of 250 g/eq or more, an average MW of 500 or more, preferably 10,000 or more when used as a baking coating, and further, is a polyhydroxy polyether resin having the structural unit of the present invention which has a self film forming ability. The non-crystalline epoxy resin of the present invention can form a cured coated film having excellent heat resistance, boiling water resistance and flexibility with good adhesion. In addition, when a cured coated film is produced characterized by a polymer epoxy resin of the present invention

having an epoxy equivalent of 2100 g/eq and a polyhydroxy polyether resin having an epoxy equivalent of 35000 g/eq, it exhibits a coating film which is suitable for a baking coating and exhibits excellent heat resistance and retort whitening resistance. These features are a significant improvement over a universal bisphenol A resin and when middle molecular weight epoxy resins according to the present invention having an epoxy equivalent of from 800 to 2000 g/eq are used for powder coating with a crystalline epoxy resin having a low epoxy equivalent on the order of 189 g/eq, flexibility and adhesion are remarkably improved over the crystalline epoxy alone.

In view of the foregoing, Applicants respectfully submit that the non-crystalline epoxy resin of the present claims is neither disclosed nor suggested by the prior art nor are the improved results obtained with the epoxy of the present invention. Applicants therefore respectfully submit that the examiner's rejections should be withdrawn and that the present application is now in condition for allowance. An early notice of allowance is earnestly solicited.

Respectfully submitted,



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